354. Musculoskeletal System I  
Winter. 4(3-3) Seventh-term Veterinary Medicine students. 
Diagnosis and treatment of musculoskeletal diseases of animals with emphasis on pathological changes, radiological techniques, and interpretation of radiographs. Surgical procedures applicable to small animals will be demonstrated.

355. Veterinary Toxicology  
Spring. 4(4) Eighth-term Veterinary Medicine students. 
Pharmacological basis and pathological features of diseases of animals caused by common toxic chemicals with emphasis on clinical manifestations, diagnosis, prevention, and treatment.

356. Visual and Auditory Systems  
Spring. 3(3-0) Eighth-term Veterinary Medicine students. 
Methods of examination, diagnosis, and treatment of diseases involving the eyes or ears of animals with emphasis on the anatomical, physiological, and pathological features.

357. Musculoskeletal System II  
Spring. 5(2-9) Eighth-term Veterinary Medicine students. 
Diagnosis, prognosis, and management of musculoskeletal diseases of the equine with emphasis on anatomical relationships to normal and abnormal function. Surgical procedures applicable to equine and ruminant will be performed.

358. Orthopedic Surgery  
Spring. 5(4-6) Eighth-term Veterinary Medicine students. 
Principles of orthopedic surgery and anatomical relations of the musculoskeletal systems in the canine and feline.

359. Veterinary Medical History, Ethics, Jurisprudence, and Epidemiology  
Spring. 2(3-0) Eighth-term Veterinary Medicine students. 
Historical background, ethical principles, and legal responsibilities of the veterinary medical profession. Epidemiological problems will be resolved and discussed.

602. Veterinary Practice Management and Jurisprudence  
Spring. 3(3-0) Satisfactory completion of Term 7 of the professional veterinary program, approval of department. 
Basic skills and legal responsibilities necessary to establish and effectively manage a practice of veterinary medicine.

ZOOLOGY  
ZOL  
College of Human Medicine  
College of Natural Science  
College of Osteopathic Medicine  

1DC. Resource Ecology and Man  
For course description, see Interdisciplinary Courses.

301. Nature and Man  
Spring. 4(2-6) Three terms of natural science; not open to zoology majors. 
Relates man to his natural environment. Chief emphasis on identifying characteristic animal life in broad areas of nature and how man fits or misfits into these. Lectures, laboratory and field trips illustrate this relationship.

302. Vertebrate Life of the Past  
Fall. 3(3-0) One course in physical or biological science or junior, interdepartmental with and administered by the Department of Geology. 
Fossil vertebrates from fish to man.

303. Introductory Animal Systematics  
Fall. 5(5-0) B S 212. 
General survey of animals including origin, evolution and dispersal, morphological characteristics, reproductive patterns, behavior, ecology and zoogeography of invertebrates and vertebrates.

304. Biology, Behavior and Man  
Winter. 3(3-0) Juniors; not open to zoology majors. 
Examines philosophical and biological issues which make the study of animal behavior relevant to man. Emphasizes history of animal behavior, current theories, and experiments relating biological and environmental determinants of adaptive and non-adaptive behavior patterns.

317. Principles of Development  
Fall, Spring. 3(3-0) B S 212. 
Development of animals, especially vertebrates. Principles are illustrated by modern experimental studies of developmental problems.
401. Comparative Physiology I
Fall, 4(3-4) PSL 240 or B S 312 and
CME 152. Interdepartmental with and adminis­
tered by the Department of Physiology.
A comparison of osmoregulation, digestion, res­
piration, and other physiological processes in a
wide range of organisms.

402. Comparative Physiology II
Winter, 4(4-0) PSL 401 or approval of
department. Interdepartmental with the De­
partment of Physiology.
A comparison of sensory, motor, endocrine and
other integrative mechanisms in animals.

404. Biological and Ecological
Concepts for Engineers and
Mathematicians
Winter, 3(3-0) Approval of department.
Interdepartmental with Systems Science.
Biological and ecological concepts important to
formal analysis of living systems, vital prop­
eties, processes, and limitations; population
dynamics, selection, competition, and predation;
ecological community structure and function;
industrialized ecosystem.

405. Experiments in Zoology I
Fall, 3(0-9) Approval of instructor.
A laboratory for Zoology majors. An integrated
series of selected experiments in the topics of
behavior, ecology and physiology.

406. Experiments in Zoology II
Winter, 3(0-9) Approval of instructor.
A laboratory for Zoology majors. An integrated
series of selected experiments in topics of cell
biology, embryology and genetics.

407. Experiments in Zoology III
Spring, 3(0-9) ZOL 405 or ZOL 406, ap­
proval of instructor.
A laboratory for Zoology majors. Special prob­
lems.

408. Freshwater Ecology
Summer. 6 Credits. B S 212 or approval of
department. Given at W. K. Kellogg Biological
Station. Interdepartmental with Biological Sci­
cence and the Department of Botany and Plant
Pathology and administered by Biological Sci­
ence.
The ecology of freshwater ecosystems, their biotic
structure and the functional interrelationships of
environmental variables regulating population
dynamics, productivity and community struc­
ture. Extensive field investigations.

410. Terrestrial Ecology
Summer. 6 credits. B S 212 or approval of
department. Given at W. K. Kellogg Biological
Station. Interdepartmental with Biological Sci­
cence and the Department of Botany and Plant
Pathology and administered by Biological Sci­
ence.
Factors determining distribution and abun­
dance of plants and animals in the terrestrial
environment. Extensive field investigations of
several types of terrestrial communities in light
of current theory.

413. Animal Behavior
Spring, 4(4-0) B S 212.
Description of the known behavior of the vari­
sous vertebrate and invertebrate phyla with emphasis
upon adaptive significance. This special atten­
tion will be given to mating, defensive, and nutritive
behavior. The genetics and ecology of behav­
ioral patterns will be presented where known.
Behavior will be related to the ecology of various animal populations.

414. Biological Mechanisms of
Animal Behavior
Winter of odd-numbered years. 3(3-0)
or 5(3-6) ZOL 413 recommended.
Consideration of neurochemical and behavioral
mechanisms controlling behavior. Emphasis will be
upon mammalian systems and will deal with
the assumptions which underlie current concepts in the
biology of behavior.

415. Ecological Aspects of Animal
Behavior
Fall, 4(4-0) ZOL 413.
Consideration of orientation, navigation and
homing behavior, food preferences, habitat
selection, exploration, behavioral periodicity,
communication, social organization and the
embryology of behavior. In both vertebrates and
invertebrates.

417. Advanced Developmental
Biology
Spring, 3(3-0) or 5(3-6) ZOL 317.
Molecular and cellular biology of development.
Complementary laboratory exercises with em­
phasis on experiments.

420. Ecology of Animal Parasites
Summer. 6 Credits. B S 212 or approval of
department. Given at W. K. Kellogg Biological
Station. Interdepartmental with the Depart­
mens of Microbiology and Public Health and
Public Health and Wildlife administered by the
Department of Microbiology and Public Health.
Parasitism of animals by protozoa, helminths and
arthropods with emphasis on the interactions
of host-parasite associations with the natural
environments.

428. Morphology of the Chordates
Winter, Spring, 3(3-6) ZOL 303 or F W
301 or approval of instructor.
Comparative and functional morphology of
chordates. Laboratory includes dissection of rep­
resentatives of most vertebrate classes.

430. Vertebrate Paleontology
Winter, 4(3-3) ZOL 428, or approval of
department. Interdepartmental with and
administered by the Department of Geology.
Fossil vertebrates with emphasis on the evolu­
tion of major groups. Laboratories on modern
techniques and on the identification and inter­
pretation of fossils.

437. Invertebrate Paleontology
Fall, 4(4-4) GLC 202 or ZOL 303 or
approval of department. Interdepartmental
with and administered by the Department of
Geology.
Systematics and evolution of marine inverte­
brates; uses of fossils in correlation and deline­
ation of geologic time; structure and morphology
of fossils as related to evolutionary development.

438. Paleocology
Spring, 4(3-4) GLC 202 or ZOL 389 or
approval of department. Interdepartmental
with and administered by the Department of
Geology.
Distribution and abundance of marine fossils;
response of skeletal morphology to environmen­
tal conditions; use of fossils in reconstructing
ancient climates and depositional environments.

441. Fundamental Genetics
Fall, Spring, 3(3-0) B S 212. Students
may not receive credit in more than one of
the following: ZOL 341, ZOL 441.
Survey of principles of heredity in animals,
plants, and microorganisms. Serves as single
course in genetics for majors in any of the biolog­
ical sciences, and as prerequisite for further work
in genetics.

442. Advanced Genetics
Winter, 3(3-0) or 5(2-9) ZOL 441; MTH
168 or MTH 111 recommended.
Population genetics and the genetic analysis of
evolution. Optional laboratory with individual
research projects.

443. Developmental Genetics
Spring, 4(4-0) ZOL 441 and ZOL 317.
Mechanisms of gene action. Role of genes in the
embryology, morphology, and physiology of
organisms.

456. Foundations of Developmental
Biology
Winter of even-numbered years. 3(3-0)
ZOL 317, ZOL 417 recommended.
Reading and discussion of original research
which posed significant problems of modern de­
velopmental biology.

460. Field Ornithology
Spring. 3 credits. B S 212 or approval of
department. Given at W. K. Kellogg Biological
Station.
The study of birds of the regional area, with
emphasis on field techniques in relation to prob­
lems in avian identification, ecology and behav­
or.

461. Ornithology
Winter. 4(4-0) ZOL 320 or ZOL 428.
Principles of classification, structure, distribu­
tion, migration, population biology and life his­
tory of birds. Identification of birds by size, form
and song.

462. Laboratory in Ornithology
Spring, 3(0-9) ZOL 461.
Field work with avian populations, foraging be­
havior, territoriality, time-activity, habitat selec­
tion and selected research topics.

471. Ichthyology
Spring, 3(2-3) F W 376 or ZOL 428.
Interdepartmental with and administered
by the Department of Fisheries and
Wildlife.
Classification and Natural history of fishes.
Emphasis on food, game, and land fishes.

476. Limnology
Winter, 3(3-0) CME 131 and CME 161;
BOT 450 or ZOL 389. Students may not receive
credit for both F W 376 and F W 476.
Interdepartmental with and administered by the
Department of Fisheries and Wildlife.
Ecology of lakes and streams with special refer­
cence to physical, chemical and biological factors
affecting their productivity.

477. Limnological Methods
Winter, 3(0-9) ZOL 491, F W 476 cor­
currently; ENT 301, ENT 302 recommended.
Interdepartmental with and administered by the
Department of Fisheries and Wildlife.
Methods and instruments of limnological field
investigation on lakes and streams.

479. Soil Zoology
Fall. 4(2-6) B S 212.
Ecology and biology of soil-dwelling animals,
with emphasis placed on protozoa, nematodes
and arthropods.

480. Biology of Fresh-Water and
Terrestrial Invertebrates
Summer, 8 credits, ZOL 325 or ap­
proval of department. Given at W. K. Kellogg
Biological Station.
Systematics and ecology of invertebrates with
emphasis on the local fauna.
451. Invertebrate Zoology  
Fall, 3(3-6) ZOL 320 or approval of department.  
Biological study of invertebrates with specialization to their natural history, classification, distribution, and economic importance.

482. Biology of the Protozoa  
Winter, 3(3-0) or 5(3-6) B S 212.  
Structures and functions of animal-like, eukaryotic microorganisms.

483. Physiological Ecology  
Winter, 4(3-2) B S 212.  
Aspects of physiology that bear particularly on the interrelationships between animals and their environments.

454. Herpetology  
Spring, 5(3-6) ZOL 420 or ZOL 428.  
Classification and natural history of amphibians and reptiles, with emphasis on Michigan species.

486. Mammalogy  
Fall, 4(2-6) ZOL 320 or ZOL 428.  
Classification, distribution, natural history of mammals with emphasis on Michigan species. Field studies, preparation of study specimens.

459. Animal Distribution  
Winter, 3(3-0) ZOL 441; ZOL 399 recommended.  
Principles and patterns of animal distribution. Emphasis on major faunal regions, center of origins, and concepts relating to the distribution of modern vertebrates.

492. Cytochemistry  
Spring, 4(3-3) B S 212.  
General principles of microscopy, microtomy, fixation, embedding and sectioning of animal tissues; study of various cellular organelles and the localization of lipids, carbohydrates, proteins, nucleic acids and various hydrolytic enzymes in the cells.

495. Undergraduate Seminar  
Fall, Winter, Spring, 3(1-3) May reenroll for a maximum of 3 credits. Juniors, with approval of department.  
Reading and discussion of articles relating to economic, social and environmental impact of new discoveries in biological sciences.

497. Principles of Endocrinology  
Winter, 4(4-0) One-year organic chemistry, ZOL 317. Interdepartmental with the Department of Physiology.  
Hormonal principles, illustrated by experimental observations, in vertebrates and invertebrates. Emphasis on cellular endocrinology. Group discussion, background in organic chemistry and cell biology strongly recommended. Term paper required.

499. Undergraduate Thesis  
Fall, Winter, Spring, Summer, 1 to 6 credits. May reenroll for a maximum of 12 credits. Juniors, written approval of instructor. Laboratory research culminating in preparation and defense of an undergraduate thesis.

804A. Neuroscience Laboratory I  
Winter, 5(2-4) Approval of instructor. Interdepartmental with the departments of Biophysics, Physiology, and Psychology and administered by the Department of Psychology. Development of skills in the methods, techniques and instrumentation necessary for research in a variety of areas concerned with neuroscience.

804B. Neuroscience Laboratory II  
Spring, 5(2-4) PSY 804A. Interdepartmental with the departments of Biophysics, Physiology and Psychology and administered by the Department of Psychology. Continued in ZOL 804A.

817. Ecology of Zooplankton  
Summer of every third year. Given in 1977, 3 credits. Given at W. K. Kellogg Biological Station.

821. Ontogeny of Behavior  
Winter of even-numbered years, 4(4-0) ZOL 317, ZOL 413.  
Changing patterns of behavior during the development of individual animals; effects of experimental control of external environment, and neurological and chemical intervention upon behavior.

825. Tropical Biology: An Ecological Approach  
Winter, Summer, 2 credits. Approval of department and acceptance by Organization for Tropical Studies. Interdepartmental with and administered by the Department of Botany and Plant Pathology.

832. Neurological and Hormonal Correlates of Animal Behavior  
Spring, 4(4-0) ZOL 414, ZOL 415.  
Lectures, papers and discussions on the neural and hormonal determinants of animal behavior. Emphasis will be placed upon mammalian behavior.

833. Advanced Vertebrate Paleontology  
Winter of even-numbered years, 3(3-0) GLG 430 or approval of department. Interdepartmental with and administered by the Department of Geology.  
Recent advances and controversial issues in vertebrate paleontology including origin, classification, phylogeny, and stratigraphic relationships of fossil vertebrates.

839. Population Ecology  
Summer, 6 credits. Approval of department. Given at W. K. Kellogg Biological Station. Interdepartmental with the Department of Botany and Plant Pathology.

841. Ecosystem Analysis, Design, and Management  
Spring, 3(3-6) SYS 442 or ZOL 404. Interdepartmental with and administered by Systems Science.

533. Advanced Vertebrate Paleontology  
Fall, 3(2-4) GLG 437 or GLG 438. Interdepartmental with and administered by the Department of Geology. Application of mathematical tools to paleontological problems, including statistical applications and numerical taxonomy, computer applications.

C. Paleocology  
Fall, 3(3-4) GLG 437 or GLG 438. Interdepartmental with and administered by the Department of Geology. Advanced problems in population, community, and province level paleoecology, primarily of marine invertebrates, including study of taxonomy, diversity, and adaptation.

D. Developmental Paleontology  
Fall, 3(3-6) GLG 437 or GLG 438, ZOL 317 or approval of department. Interdepartmental with and administered by the Department of Geology.

E. Evolutionary Paleontology  
Fall, 3(2-4) GLG 437 or GLG 438. Interdepartmental with and administered by the Department of Geology. Aspects of evolutionary biology that can be studied in the fossil record, with emphasis on marine invertebrates.

844. Problems in Human Genetics  
Spring, 3(3-0) ZOL 441 or approval of department.  
Interdepartmental with and administered by the Department of Biological Sciences.  
Groups of students from various biological and non-biological disciplines will synthesize and analyze models of selected biological systems. Projects should yield information relevant to solution of contemporary ecological problems.

544. Problems in Biogeography and Systematics  
Spring, 3(3-0) ZOL 441 or approval of department.  
A historical view of evolutionary thought, a presentation of the evolution of prebiological systems and a critical evaluation of the evolution of genetic systems.
847. Analysis of Gene Organization and Transmission
Winter of odd-numbered years. 4(4-0)
ZOL 441 and approval of department.
Formal and molecular analysis of gene organization and transmission in higher eucaryotes. Intended for graduate students with background in genetics and/or cytogenetics.

850. Ultrastructure
Fall. 4(2-6) BOT 427.
New developments in instrumentation and techniques of electron microscopy and their practical application in studying morphological and physiological changes in various organ systems.

857. Experimental Morphology
Spring. 4(3-1) ZOL 317.
Analysis of mechanisms of morphogenesis, particularly as these occur in post-gastrular stages of development. The significance of tissue interactions in developing and regenerating systems will be emphasized.

858. Neuroembryology
Spring. 4(4-0) ZOL 318 and approval of department.
Experimental analyses of morphogenesis of vertebrate nervous systems.

859. Analysis of Hormone Action
Spring. 4(4-0) ZOL 317 or approval of department. Interdepartmental with the Department of Physiology.
Discussion of recent work on the molecular and developmental aspects of hormone action in vertebrates and invertebrates. Selected topics to vary from year to year.

865. Advanced Neurobiology
Spring. 3(3-0) BFY 827. Interdepartmental with the departments of Biophysics, Biomechanics, Physiology and Psychology and administered by the Department of Biomechanics.
Basic organization, structure and function of neural networks comprising sensory, motor, and autonomic systems including examples from invertebrates and vertebrates.

871. Ecology of Fishes
Summer. 3(1-5) Approval of instructor or ZOL 386 or FW 475. Given at the W. K. Kellogg Biological Station. Interdepartmental with the Department of Fisheries and Wildlife.
Exploration of ecological problems with particular emphasis on growth, food, and habitat selection, population biology, and niche relations. Field and experimental investigations of fish communities.

878. Comparative Limnology
(478) Summer. 6 credits. Approval of department. Given at W. K. Kellogg Biological Station. Interdepartmental with the Department of Botany and Plant Pathology.
Theoretical concepts and methods of analysis of environmental parameters influencing productivity of freshwater. Comparative field investigations of lakes, streams, and other aquatic habitats.

881. Biology of the Arthropoda
Winter. 5(3-6) ZOL 481 or approval of department. Interdepartmental with the Department of Entomology.
Ecology, life cycles, morphology, taxonomy, and distribution of arthropods other than insects.

882. Cellular Morphogenesis
Fall. 2(2-0) One course in biochemistry, approval of department.
Selected topics on the structure, biological processes, and differentiation of living cells.

883. Laboratory in Cellular Morphogenesis
Fall. 2(0-6) Approval of department.
Laboratory work in cellular morphogenesis accompanying ZOL 882.

885. Vertebrate Neural Systems I
Fall or odd-numbered years. 3(3-4) Approval of department. ANT 815 and BFY 827 recommended. Interdepartmental with the departments of Biophysics, Physiology and Psychology and administered by the Department of Psychology.
Structure and function of major component systems of vertebrate brains, their evolution, ontogeny and comparative analysis in mammals, birds, reptiles, amphibians, and fish. Interaction of behavioral, anatomical and physiological studies.

886. Vertebrate Neural Systems II
Fall of even-numbered years. 3(3-4) PSY 885. Interdepartmental with the departments of Psychology, Biophysics and Physiology.
Continuation of ZOL 885. Major component systems of vertebrate brains, their evolution, ontogeny, and comparative analysis in mammals, birds, reptiles, amphibians and fish. Interaction of behavioral, anatomical, and physiological studies.

890. Special Problems
Fall, Winter, Spring, Summer. 1 to 15 credits. Two years of undergraduate zoology. Approval of department. Consideration of current problems.

891. Current Topics in Ecological Research
Summer. 1 credit. May reenroll for a maximum of 4 credits. Approval of department. Given at W. K. Kellogg Biological Station. Discussions and special problem work; current theoretical views and investigations; treatment of the dynamics of energy and biomass in terrestrial and aquatic ecosystems, methods of analysis.

892. Dynamics of Biologic Populations
Winter. 5(4-3) One statistics course, 1 ecology course or approval of department.
Quantitative analyses of the dynamics, production, regulation, energetics and distribution of animal populations.

893. Fertilization and Early Embryogenesis
Fall. 3(3-0) Developmental biology, biochemistry and approval of department. ZOL 894 recommended concurrently. Developmental biology of early stages of animal life, emphasis on physiology and biochemistry of marine invertebrate eggs.

894. Methods in Cellular and Developmental Biology
Fall. 3(4-0) Cell, and developmental biology, biochemistry and approval of department.
Theory and practice of research methods in cellular and developmental biology, with emphasis on physicochemical approaches.